Senior Design Project Data Sheet

Project #	Project Name	Project Track	Project Family
P11412	Clean Water UV Treatment	Energy & Sustainable Systems	Sustainable Water Systems
Start Term	**Team Guide**	**Project Sponsor**	**Doc. Revision**
2010-2	Sarah Brownell	Clean Water for the World & B9 Plastics	1.1

Project Description

Project Background:

This project is part of the Sustainable Water Systems family on the Senior Design Project Roadmap with the mission to provide a compelling solution to the problem of sufficient, accessible, economical and sustainable potable water supplies for the world's population. The team will be working with two not for profit organizations; B9 Plastics and Clean Water for the World (CWFTW).

Problem Statement:

The mission of this Multi-Disciplinary Senior Design Team is to provide a cost efficient water treatment system using Ultra Violet (UV) disinfection technologies to supply drinking water to rural communities in Haiti and Africa. We are aiming to lower the overall cost of the current system and improve upon design to increase maintainability and efficiency.

Objectives/Scope:

1. Redesign the housing.
2. Provide incentive to operate and maintain water system
3. Provide adequate water filtration and disinfection
4. Redesign UV chambers
5. Design low cost manual power generation
6. Improving the power system and making it easy to install and connect the system

Deliverables:

- CW4TW system redesign, drawings and specifications (including solar power with cell phone charging.
- CFD analysis showing expected UV dose of disinfection chamber
- CW4TW system model
- UV chamber model ready for further biological testing
- User Manual
- Manual power system design drawings and specifications
- B9 Manual Power system model

Expected Project Benefits:

- Creating water treatment system
- Creating a system that will allow people to have easier and cheaper access to clean water.
- Providing power that treats water but could be used for many other functions.
- Basis for future senior designs

Core Team Members:

- Andrew Sullivan (Project Manager)
- Bobby Zwecker
- Heather Hussain
- Daniel Lopez
- Andrew Baglio

Strategy & Approach

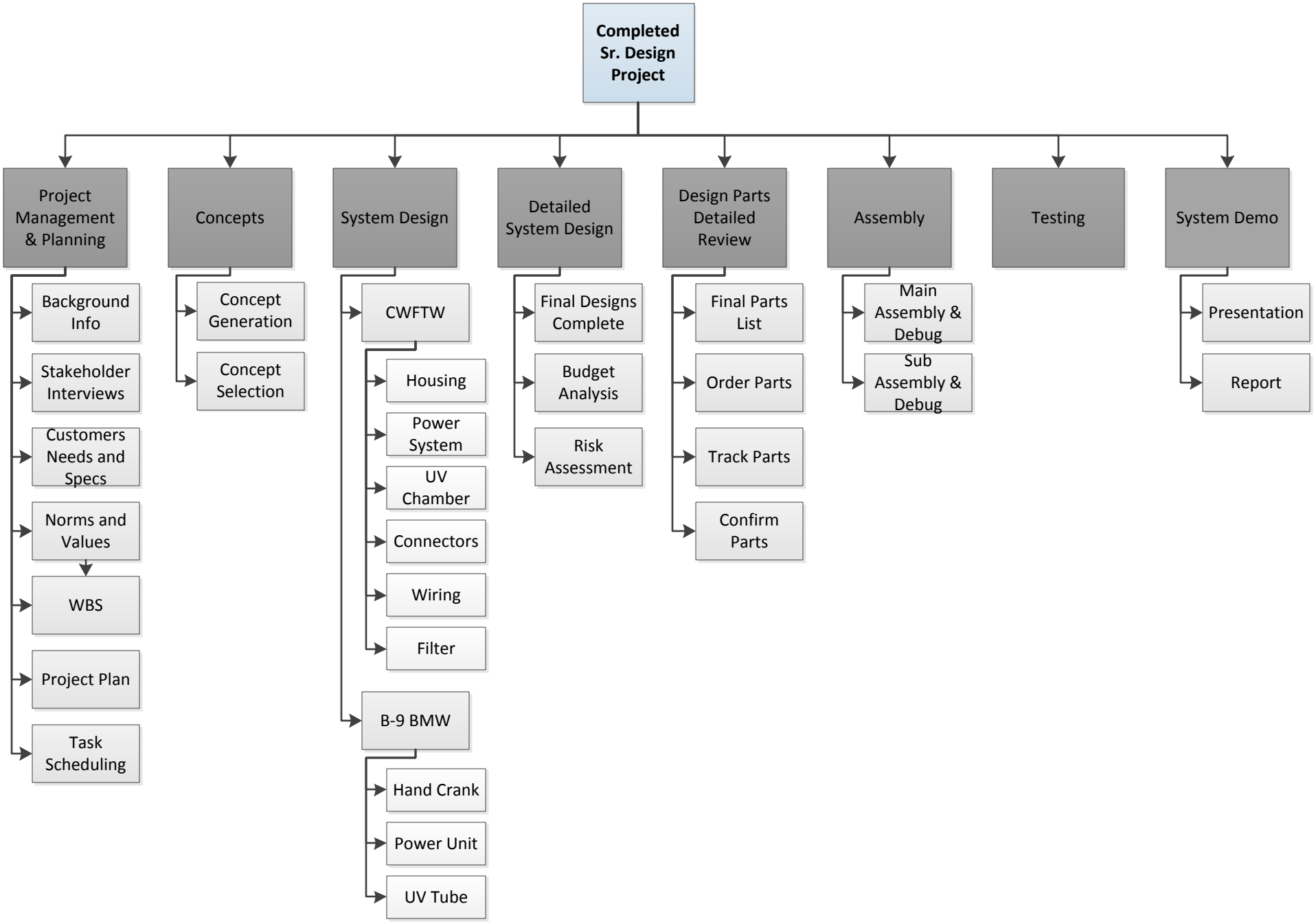
Assumptions & Constraints:

1. Understanding the cultural restriction associated with operators of the device
2. Total project budget of $2200.
3. End product less than $700 for CWFTW.
4. End product less than $50 for lots of 1000 for B9 Better Water Maker.
5. Creating manual power generation that requires minimal physical exertion
6. Incentive cannot influence the functionality of the disinfection process

Issues & Risks:

- Project is new area of study for many
- Obtaining parts and hardware that can be implemented with current systems.
- Ordering and tracking parts with correct lead times.
- Unplanned rework or machining
- Device does not comply to cultural limitations
- B9 device does not meet power output requirements
- B9 device requires too much energy to operate.
- CWFTW enclosure is not closed from the environment
- Cost does not meet requirement

Work Breakdown Structure



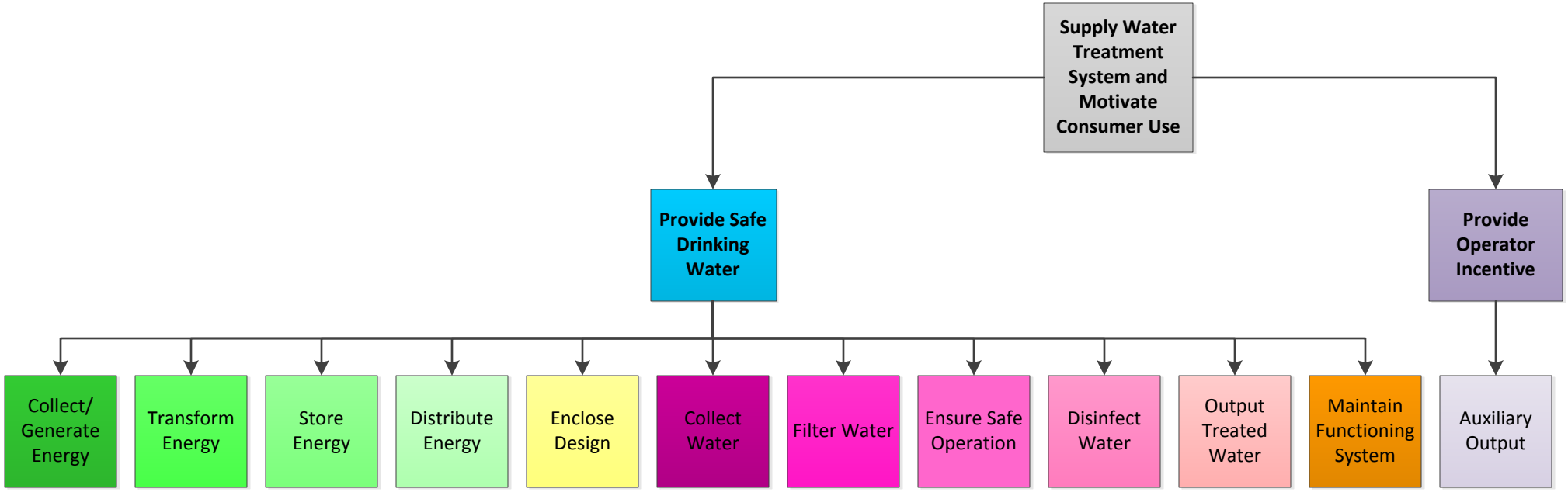
Clean Water for the World Needs Summary		
Need Number	**Description of Need**	**Importance**
Need 1	The device is easy to install	3
Need 2	The device is easy to mount and dismount from the wall	1
Need 3	The device will have weight reduction for enclosure	1
Need 4	The device is easy to use and maintain with limited training	9
Need 5	The enclosure is insect repellent	9
Need 6	The device is weather resistant	9
Need 8	The device indicates UV lamp status to the user	9
Need 9	The device indicates filer status to the user	9
Need 11	The enclosure is resistant to shipping hazards	3
Need 12	The device is more compact than previous generation	1
Need 13	The device has a more compact chamber design than previous generations	1
Need 14	The device produces adequate disinfection of water by meeting standards	9
Need 15	The device produces clean water free of by-products (below EPA limits)	9
Need 16	The device has a safety feature to ensure that only treated water is outputted from the device	9
Need 19	The device provides incentive to operate	9
Need 20	The device provides incentive to maintain	9
Need 21	The device provides means for charging cell phone	3
Need 22	The device provides theft deterrence for solar panels	9
Need 23	The device has improved power storage (compared to previous generations)	3
Need 24	The device has improved power generation (compared to previous generations)	3
Need 25	The device has the ability to interface with a manual power generation system	3
Need 26	The device enclosure is cost efficient	9
Need 27	The device UV chamber is cost efficient	9
Need 28	The device requires cost efficient maintenance	3

B-9 Plastics Needs Summary Need Number		
Need Number	**Description of Need**	**Importance**
Need 1	The device is easy to install	9
Need 2	The device is easy to maintain	9
Need 3	The device incorporates standard tooling for repair	3
Need 4	The device includes an easy to read user manual with pictures	3
Need 5	The device is compatible with other UV systems	3
Need 10	The device is portable	3
Need 11	The device is shippable	1
Need 12	The device is cost efficient	9
Need 13	The UV lamp is powered manually	9
Need 14	The device requires limited level of exertion for manual power generation	9

List of Metrics for Clean Water for the World						
Metric No.	**Need Nos.**	**Metric**	**Importance**	**Units**	**Marginal Value**	**Ideal Value**
1	26, 27	total cost of unit	9	USD	<700	400
2	26	cost of enclosure	3	USD		
3	3	weight of enclosure	3	lbs		
4	11	strength of enclosure: # of drops at height of 3 ft	1	#		>10
5	5,6	clearance of protruding components into/out of enclosure	9	in^2		
6	12	volume of enclosure	3	ft^3	3	2
7	5,6	enclosure life due to exposure to environmental elements	9	years		>5
8	27	cost of UV chamber	9	USD	210	<100
9		power used by UV lamp	1	W	<30	<10
10	14	intensity of UV lamp	9	mJ/cm^2		
11	14	wavelength of UV light	9	nm	200-280	254
12	24	power produced by solar panels	3	W		
13	23	power stored by batteries	3	Wh		
14		turbidity level of initial sample	9	NTU		<1
15		flow rate through system	3	gpm	5	5
16		life of UV lamp	1	years	1	>>1
17	14	fluence (dose) of UV	9	mJ/cm^2	>40	>40
18	19,20,21	power of phone charger	1	W		>5
19	19,20,21	power available to charge phones	1	Wh		
20	1,2	assembly/disassembly time for maintenance	3	min		<5
21	1	standard tools for routine maintenance	3	list		
22		cost to maintain (bulbs & filters)	3	USD/year	83	<50
23	22	time to disconnect solar panels (theft deterrence)	1	min		<5
24	16	UV lamp activated to allow water flow	9	binary	yes	yes
25	14	NSF standards met	9	binary	yes	yes
26	1,4	training period required	3	min		<5
27	14,15	EPA standards for by-products met	9	binary	yes	yes
28	8	UV lamp status indicator	3	binary	yes	yes
29	9	filter status indicator	3	binary	yes	yes
30	13	overall size of UV chamber	3	in^3		
31	25	manual power generation	1	W		>30
32	28	cost to repair unit	3	USD		

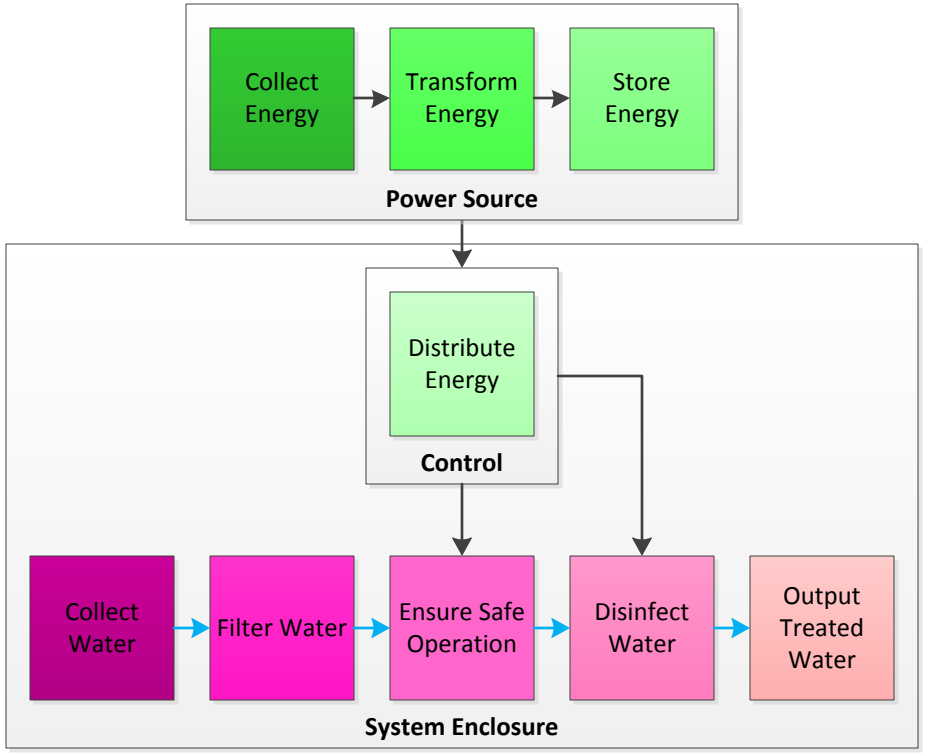
List of Metrics for B-9 Plastics						
Metric No.	**Need Nos.**	**Metric**	**Importance**	**Units**	**Marginal Value**	**Ideal Value**
1	12	cost of unit	9	USD		<50
2	10, 11	size of unit	3	ft^3	<1	<1
3	10, 11	weight of unit	3	lbs		<20
4	13	power produced	9	W	17	100
5	14	effort required	3	calories/gal		
6	1	time required for installation	9	min		<30
7	2	time required for maintenance	9	min		
8	4	training needed to operate	9	min		<5
9	3	standard tools needed for repair	9	list	phillips screwdriver	phillips screwdriver
10	5	compatible with CW4TW UV system	1	binary	no	yes

Overall Functional Analysis

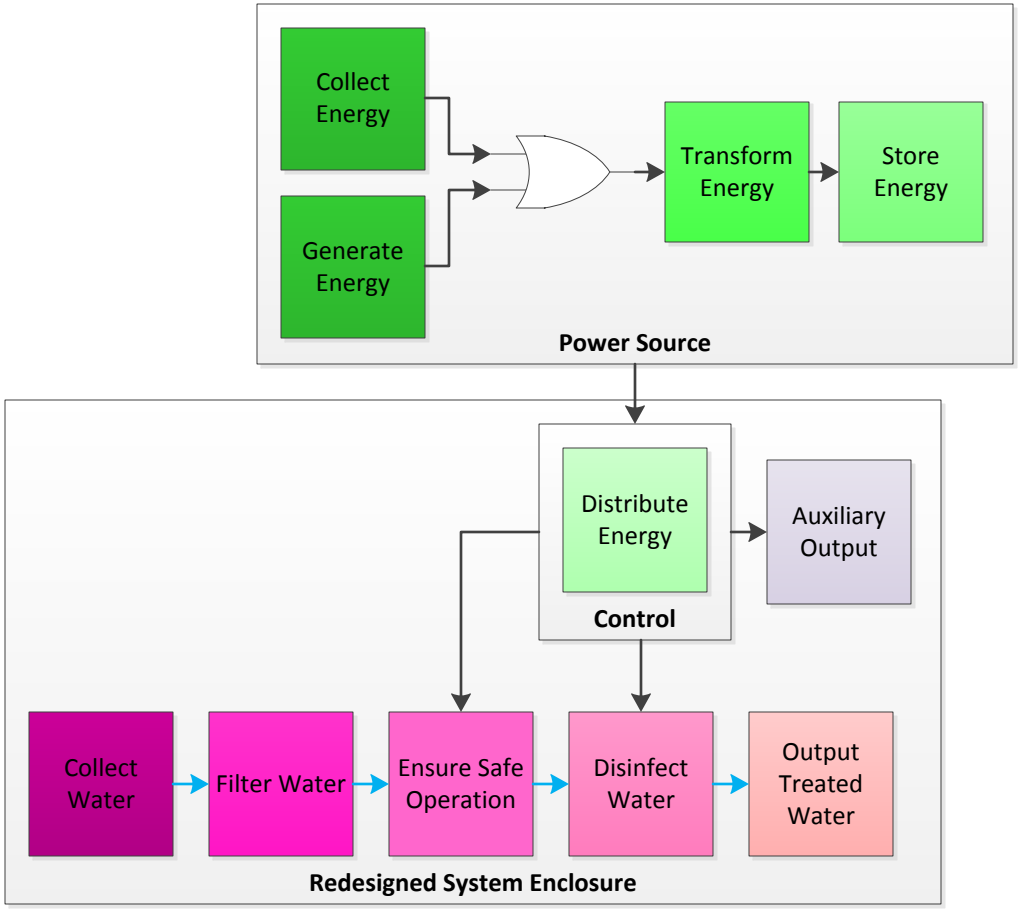


Water Treatment System

Current System



Proposed System

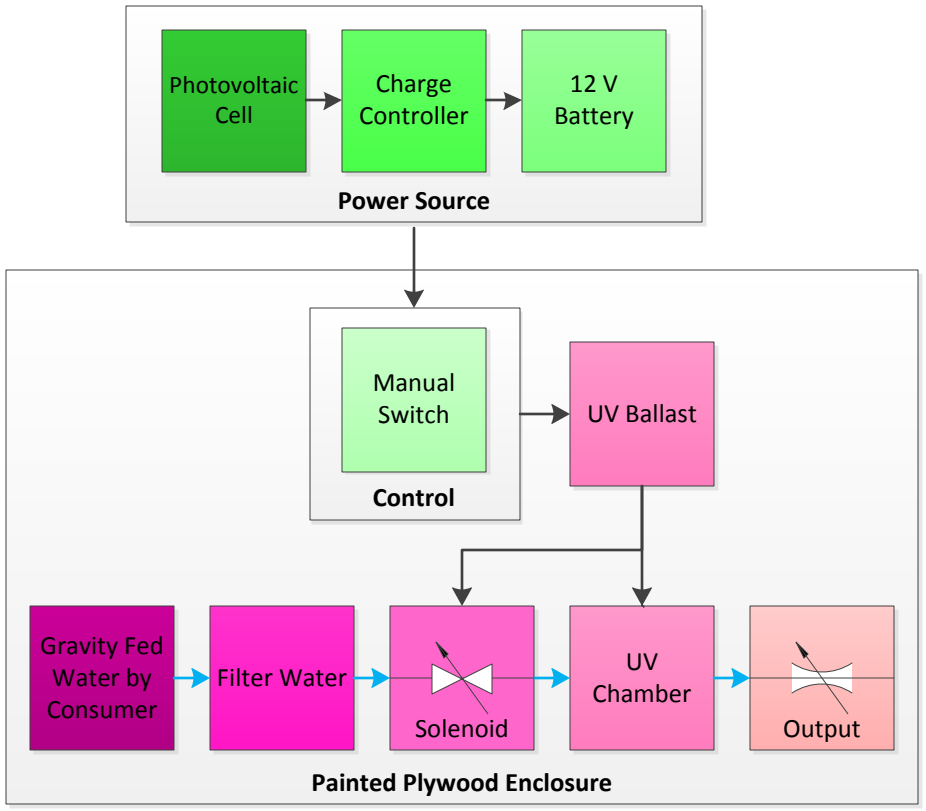


Water

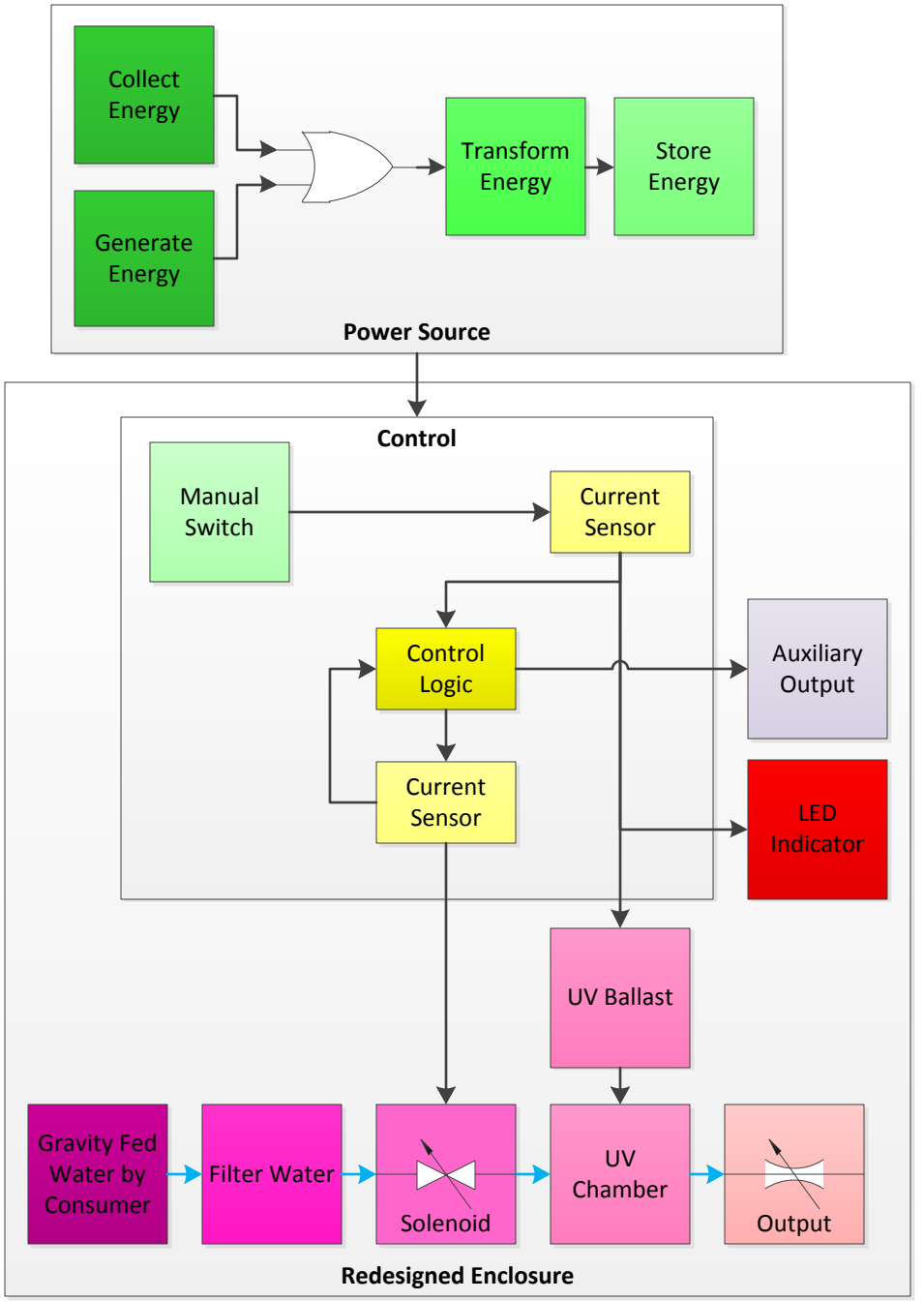
Electrical

Water Treatment System – Component Level

Current System



Proposed System



Water

Electrical

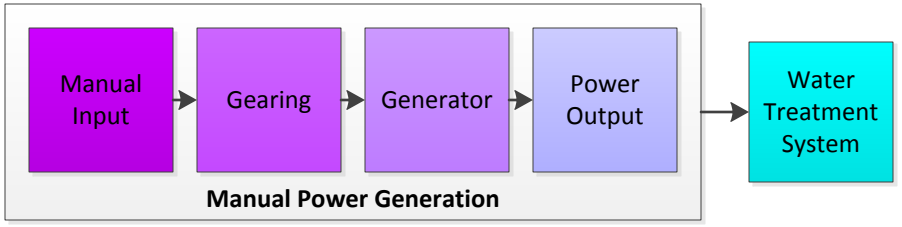
Clean Water for the World, Incentive for Using Water Treatment System				
	Option #1	**Option #2**	**Option #3**	**Option #4**
	Cell-Phone Charging System (reference)	**Power for home/lighting**	**Manual Power Generation**	**Music while treating water**
Selection Criteria	**Score**	**Score**	**Score**	**Score**
Amusement	0	0	+	+
Effectiveness	0	+	-	-
Practicality	0	+	-	-
Profitability	0	-	-	-
Scope of Project falls within rigorous timeline	0	-	+	+
Sum +'s	0	2	2	2
Sum 0's	5	1	0	0
Sum -'s	0	2	3	3
Net Score	0	0	-1	-1
Rank	**1**	**1**	**3**	**3**

Clean Water for the World, Enclosure Design					
	Option #1	**Option #2**	**Option #3**	**Option #4**	**Option #5**
	Untreated Plywood (reference)	**Pressure Treated Wood**	**Plastic**	**Metal Enclosure**	**Metal Frame with Canvas**
Selection Criteria	**Score**	**Score**	**Score**	**Score**	**Score**
Sealed	0	0	+	+	-
Insect Repellant	0	+	+	+	-
Resistance to Environmental Effects	0	+	+	+	+
Physical Durability	0	0	+	+	-
Cost	0	-	-	-	-
Shipping Container	0	0	0	0	-
Ability to access internal components	0	0	0	0	+
Weight	0	0	+	-	-
Sum +'s	0	2	5	4	2
Sum 0's	8	5	2	2	0
Sum -'s	0	1	1	2	6
Net Score	0	1	4	2	-4
Rank	**4**	**3**	**1**	**2**	**5**

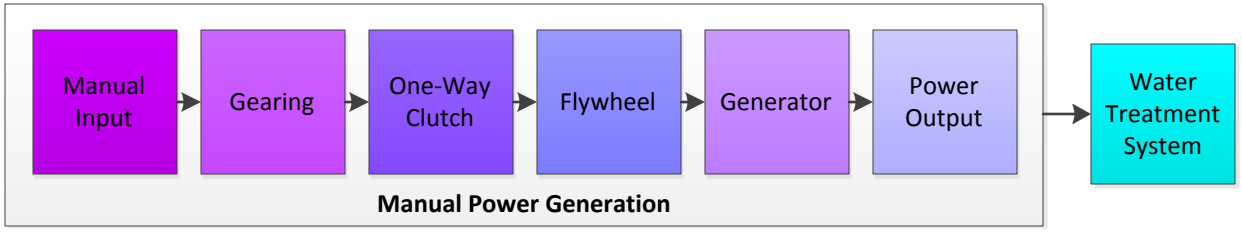
Clean Water for the World, UV Chamber							
	Option #1	**Option #2**	**Option #3**	**Option #4**	**Option #5**	**Option #6**	**Option #6**
	Purchased UV System (reference)	**Quartz Sleeve**	**Teflon Sleeve**	**Open Channel**	**Pressurized**	**Single Prong Configuration**	**Double Prong Configuration**
Selection Criteria	**Score**	**Score**	**Score**	**Score**	**Score**	**Score**	**Score**
Cost	0						
Dose	0						
Size	0						
Flow Rate	0						
Repairibility	0						
Maintenance Cost	0						
Sum +'s	0						
Sum 0's	6						
Sum -'s	0						
Net Score	0						
Rank							

Manual Power Generation System

Current System



Proposed System



B-9 Plastics, Power Generation						
	Option #1	**Option #2**	**Option #3**	**Option #4**	**Option #5**	**Option #6**
	Mechanical Hand Crank (reference)	**Hand Crank w/ Flywheel**	**Treadle**	**Elliptical**	**Revolving Spoke/Merry-Go-Round**	**See-Saw**
Selection Criteria	**Score**	**Score**	**Score**	**Score**	**Score**	**Score**
Minimal Effort Required	0	+	+	+	+	-
Ease of Installation	0	0	-	-	-	-
Durability	0	-	-	-	+	-
Safety	0	-	-	-	-	-
Cost	0	-	-	-	-	-
Efiiciency (Input/Output)	0	+	+	+	+	-
Scope of Project falls within rigorous timeline	0	+	-	-	+	-
Amusement	0	0	0	+	+	+
Sum +'s	0	3	2	3	5	1
Sum 0's	8	2	1	0	0	0
Sum -'s	0	3	5	5	3	7
Net Score	0	0	-3	-2	2	-6
Rank	**2**	**2**	**5**	**4**	**1**	**6**

ID	Risk Item	Effect	Cause	Likelihood	Severity	Importance	Action to Minimize Risk	Owner
1	Project scope too large	Project does not get completed	Tasks are larger than originally planned	3	3	9	Focusing on the deliverables instead of extras	Group
2	Parts are ordered too late	Assembly is delayed	Didn't identify correct lead times	2	3	6	Identify long lead time parts early	Group
3	Device does not comply to cultural limitations	Target consumer cannot utilize the product	Improper/insufficient research of culture	1	3	3	Research culture and customs, communicate with customer/user	Group
4	Design does not meet budget requirements	need redesign to reach production	Overdesigned	2	2	4	Focus on meeting core design requirements	Andrew Sullivan, Group
			Unforeseen costs	2	2	4	Plan ahead to understand the scope of a proposed design	
5	Parts must be reworked	Project falls behind schedule	Error in creating or reading drawings	1	2	2	Check for consistency in drawings and allow for extra time to accommodate	Robert Zwecker Andrew Baglio Heather Hussain
6	Parts need to be sent out for machining	Project falls behind schedule	Parts cannot be made in-house or can be done cheaper elsewhere	1	2	2	Allow for necessary lead time	Robert Zwecker Andrew Baglio Heather Hussain
7	Misplace parts	Project not completed within time span or within budget	Neglect, theft, delivered to wrong place	1	2	2	Take care to place parts in a secure location	Group
8	Necessary technology not available for budget allocated	Unit is not designed in the best/most efficient way possible	Higher cost of newer technologies	3	1	3	Create a design that fully utilizes current, cheaper technologies	Andrew Sullivan, Group
9	Water does not flow through system	System is unusable	Electronics or solenoid failure	1	2	2	Properly design and test electronic components	Robert Zwecker Andrew Baglio Heather Hussain
10	Components do not fit in enclosure	Unit is unprotected from environment	Improperly designed enclosure	1	3	3	Design enclosure after the unit's internals are finalized	Group
12	Unit Errors/Inconsistencies	Unit fails to meet power requirements or size restrictions	Improper measuring or converting of units	1	2	2	Label units to ensure consistency between group members	Group
13	Enclosure is not sealed to the environment	Reduced lifespan of in-field unit	Enclosure is not resistant to environmental effects	1	3	3	Understand what environmental forces unit will encounter	Group
			Enclosure allows environment to effect internal components	1	3	3	Test enclosure to ensure it meets intended performance	

ID	Risk Item	Effect	Cause	Likelihood	Severity	Importance	Action to Minimize Risk	Owner
14	Does not meet design safety features	Untreated water flows from system	Control system malfunction	2	3	6	Extensive testing to ensure safeguards are functional	Group
			Solenoid malfunction/short-circuit	1	3	3	Use of a 'power-open' solenoid and durable circuitry	
15	Device does not provide auxiliary power	Diminishes customer incentive	Auxiliary power system requires too much power	1	2	2	Ensure the auxiliary power system that is implemented efficiently utilizes the unit's surplus power	Daniel Lopez, Group
16	Device does not produce treated water that meets standards	Potential to harm end user	UV bulb is not producing specified intensity	2	3	6	Provide user with a method to know when bulb needs to be replaced due to age	Group
			Water is flowing too quickly through system	2	3	6	Restrict water flow through system	
17	B9 device does not meet power output requirements	Treatment system fails to operate	Improperly designed user input	1	3	3	Design the system to exceed the power requirements	Daniel Lopez, Group
18	B9 requires too much energy to operate	Device will be difficult to use and not provide user sufficient water	Poorly designed/implemented user interface	2	2	4	Provide design with significant mechanical advantage	Daniel Lopez, Group
19	Final cost of device does not meet customers' requirements	Device must be redesigned or cannot reach as many users	Overdesigned or not designed for manufacture	2	2	4	Plan for budget restrictions early on and design product accordingly	Andrew Sullivan, Group
20	Device is subject to theft	Product cannot be used by customer	Theft deterrent measures are not built in	2	3	6	Provide means of theft deterrence	Group
21	Inability to contact the customer or guide	Final product fails to meet customer needs	Poor relationship with customer	2	2	4	Create positive relationship with customer to ensure cooperation	Andrew Sullivan, Group
			No means of contacting customer	2	2	4	Find a representative that can accurately relate to end user	
22	Design is not durable	Device is not in service for intended lifespan	Low factor of safety and inadequate testing	1	3	3	Identify potential weaknesses, test and fortify design	Robert Zwecker Andrew Baglio Heather Hussain
			Poorly understood market	1	3	3	Research the unit's intended environment	